

**SAFETY EVALUATION REPORT  
NUCLEAR FUEL SERVICES, INC. NORTH SITE  
FINAL STATUS SURVEY REPORT,  
SURFACE SOIL IN SURVEY UNITS 1 AND 2**

**August 2013**

1. Introduction

By letter dated August 16, 2011, Nuclear Fuel Services, Inc, (NFS) submitted the Final Status Survey (FSS) Report for surface soils of Survey Units 1 and 2 of the NFS North Site Area (ref. 7). NFS requested confirmation that these survey units are suitable for unrestricted release in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, Subpart E (ref. 1 and ref. 5).

2. Background

The NFS North Site Decommissioning Plan (DP) was approved in Amendment 27 to Materials License SNM-124, dated June 19, 2001, and supplemented by information provided to satisfy Safety Condition S-47. One product of the DP was a FSS, to be performed after an area has been fully characterized and remediation has been completed.

The FSS design is an iterative process that requires appropriate site classification based on the potential radionuclide concentration levels relative to the derived concentration guideline levels (DCGLs), and incorporates a process to ensure the quality of the data obtained. In Amendment 69 to Materials License SNM-124, dated February 15, 2006, the U.S. Nuclear Regulatory Commission (NRC) approved a revised method to derive subsurface (greater than 15 cm below the ground surface) soil DCGLs and a method to perform subsurface FSSs. In the approval of Amendment 69, NFS did not ask for any revision to the requirements for surface FSS and the NRC Staff (Staff) therefore did not approve changes to the surface FSS requirements which are provided in Section 5.1 of the DP.

The Staff reviewed the original FSS Report for Survey Units 1, 3, and 10, submitted July 8, 2009, by NFS. The original FSS Report did not include discussion of the required surface survey, and NRC Staff provided an request for additional information (RAI) (December 3, 2009) on that issue. NFS provided a response to the RAIs (December 31, 2009) and the Staff and NFS had a conference call to discuss the issue January 27, 2010. The Staff completed its safety evaluation and concluded (June 15, 2010) that a surface survey was needed.

The Staff had correspondence and discussions with the licensee to clearly understand and document the FSS:

- Original FSS Report for Survey Units 1, 3, and 10 (ref. 1)
- RAIs (ref. 2)
- NFS response (ref. 3)
- NRC/NFS conference call January 27, 2010, to discuss NRC evaluation (ref. 4)
- Original FSS Report for Survey Units 2, 8, 9, 19, and 20 (ref. 5)
- Letter and safety evaluation report from NRC with conclusions on Survey Units 1, 3, and 10 (ref. 6)

Enclosure

- NFS submittal of surface final status surveys for Survey Units 1 and 2 (ref. 7)
- RAIs (ref. 8)
- NFS response (ref. 9)
- NRC/NFS meeting September 11, 2012, to discuss NRC evaluation (ref. 10)
- NFS supplemental information (revision 1, surface FSS Reports for Survey Units 1 and 2) (ref. 11)
- NFS supplemental information (revision 1, surface FSS Reports for Survey Units 1 and 2, unchanged but incorporated as an addendum to subsurface FSS report for Survey Units 2, 8, 9, 19, and 20) (ref. 12)
- NFS supplemental information (including revision 2, surface FSS Reports for Survey Units 1 and 2) (ref. 15)

### 3. Scope of the Staff Evaluation

While the focus of Amendment 69 was the methods for performing the subsurface FSS, the NFS DP provides plans for both surface soil and subsurface soil FSSs. The licensee's FSS Plan is provided in the North Site DP, Revision 3, which was submitted to the Staff May 2, 2006, and approved by letter from NRC dated May 18, 2006. The surface soils FSS Plan are documented in Chapter 5 of the DP; the subsurface FSS Plan is documented in Appendix B. Surveys of surface soils were not addressed in the original FSS Reports for (a) Survey Units 1, 3, and 10 (from 2009) and (b) Survey Units 2, 8, 9, 19, and 20 (from 2010). NFS initially was addressing surface soils separately from subsurface soils (see NFS submittal dated August 16, 2011) and the Staff has completed the review of the subsurface soils FSSs separately (ref. 13). Therefore, this Staff evaluation addresses only the surface soils FSSs. If evaluation of contamination of other media is needed prior to partial site release, that must be done separately.

### 4. Surface Final Status Survey Results

#### 4.1. Size of Survey Units

##### 4.1.1. Evaluation

Based on considerations in the Staff review of the FSSs for Survey Units 1, 3, and 10 (NRC letter dated June 15, 2010, ref. 6), the Staff concluded that the limitation of survey unit size is not necessary for the subsurface methodology. Survey Units 1 and 2 have sizes of 4534 and 7774 m<sup>2</sup>, respectively, according to the NFS Characterization Plan for Security Zone, Burial Ground and Ponds Areas, January 2007 (ref. 14). These sizes are greater than the recommended size of survey units in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (ref. 16). For the surface surveys, NFS performed a 100% walkover gamma scan. Given this complete scanning coverage, Staff considers that elevated areas of gamma-emitting radionuclides are likely to have been located if they existed. In addition, these surface surveys benefit from the subsurface sampling that has been done in the same survey units, which did not locate significant elevated concentration areas. Thus, staff concludes that limitation of the survey unit sizes for these specific surface surveys is not needed.

##### 4.1.2. Findings

The Staff finds that the survey unit sizes are adequate.

## 4.2. Determination of Number of Samples for Survey Units

### 4.2.1. Evaluation

An important issue for the survey design for the FSS is the number of samples for each survey unit. NFS determined that 15 sample locations were needed for Survey Unit 1 and 18 sample locations were needed for Survey Unit 2. The original surface FSS Reports (August 16, 2011, ref. 7) did not describe how the number of surface soil samples needed was determined for each survey unit. The Staff requested additional information from NFS (in the RAI of December 21, 2011, ref. 8). In its responses of March 1, 2012 (ref. 9), NFS stated that the number of samples and the sample locations for the surface surveys were the same as those determined for the subsurface FSSs for the two survey units. In part, the minimum number of samples was based on the standard considerations recommended by the MARSSIM (ref. 16), which the Staff considers acceptable for determining the number of sample locations for surface surveys. The Staff has concluded that the number of sample locations for the subsurface surveys are acceptable (refs. 6 and 13). The Staff agrees that use of the number and locations of samples for the subsurface survey is appropriate for the surface surveys of these survey units.

### 4.2.2. Findings

The Staff finds that the determination of the number of surface soil samples is adequate for Survey Units 1 and 2.

## 4.3. Contributions of Hard-to-Detect Radionuclides

### 4.3.1. Evaluation

The FSS Plan in the DP calls for sample analyses for hard-to-detect radionuclides. NFS did not perform such analyses, and the Staff asked NFS to account for the hard-to-detect radionuclides in an RAI (ref. 8). This issue was applicable to the subsurface FSSs for these survey units as well. The issue has been resolved for the subsurface surveys (ref. 13) and Staff agreed with NFSs commitments relative to evaluating hard-to-detect radionuclides.

In the September 11, 2012, meeting between NFS and NRC Staff (ref. 10), NFS noted that the report for the surface survey didn't address hard-to-detect nuclides because it was relying on FSS Reports for the Subsurface Characterization submitted previously for Survey Units 1 and 2. NFS stated that they believe that the surface scans should be used to confirm variance across the survey unit only. NFS stated that once a lack of variance is confirmed, the soil sample results should be used for contamination levels. NFS acknowledged that the surface survey report addressing the previous RAI should not have been submitted as a stand-alone report, but rather, it should be viewed as an Addendum to the Subsurface Characterization FSS Reports.

The original Staff determination that surface surveys were still necessary (despite NFS' disagreement) was based in part on the concept that the exposure and dose to future receptors at the site depended on the radionuclide concentrations in the surface soils (0–15 cm), in addition to concentrations in deeper soils. However, this is most critical for those radionuclides for which most of the dose would be due to the direct radiation exposure pathway. The hard-to-detect radionuclides are not significant gamma emitters, so the dose from them is due to other exposure pathways. For such other exposure pathways, it is not critical to differentiate concentrations in the top 15 cm of soil versus the top 1 m of soil; that is, the dose evaluation based on a 0–1 m layer provides a sufficient evaluation of the dose from the hard-to-detect

radionuclides. For Survey Units 1 and 2 that are considered here, NFS has performed evaluations of the hard-to-detect radionuclides for samples in the 0–1 m layer and deeper (1 m thick) layers. Results of NFS' evaluation indicated that doses from the hard-to-detect radionuclides (0.35 mrem/yr, see ref. 9) are a small fraction of the dose criterion of 25 mrem/yr. The Staff considers the evaluations of hard-to-detect radionuclides performed for the subsurface FSSs to provide reasonable assurance that hard-to-detect radionuclides are not present in significant quantities in the surface soils.

#### 4.3.2. Findings

The Staff finds that overall, the approach to hard-to-detect radionuclides and results of the surrogate evaluations for the subsurface surveys of Survey Units 1 and 2 are acceptable for the surface soil surveys of Survey Units 1 and 2.

#### 4.4. Performance of Gamma Scans

##### 4.4.1. Evaluation

Gamma scans are a critical part of the surface survey, because they address gamma-emitting radionuclides near the surface soils and also address variability of gamma-emitting radionuclide concentrations near the surface. The DP discusses performance of the gamma radiation scans. Section 5.3.2 states that investigation levels will be determined (and generally describes how the determinations would be made), instruments will be operated in audible mode, scanning speed would be such that required scan minimum detectable concentration (MDCs) will be met, and survey personnel will flag locations where audible elevation in count rate exceeds the investigation level. Section 5.2.6.3 describes the scan MDCs that would be met for the gamma scans.

In the FSS Report, NFS states that “Excluding K 40, the isotopes measured appear to be uniform and there does not appear to be any localized hotspots that would warrant investigation.” To the Staff, this statement is vague and unsupported regarding how NFS evaluated the gamma scan results. The FSS Report does not state the investigation levels, and no indication is given that investigation levels were utilized.

Based on Figure 5-2 in Section 5.3.1 of the DP, it appears to the Staff that Survey Units 1 and 2 are considered Class 2 areas. Based on recommendations in MARSSIM, investigation levels for Class 2 or 3 areas would usually be no greater than the wide-area DCGL (DCGL<sub>w</sub>), because concentrations greater than the DCGL<sub>w</sub> would indicate the area should be Class 1.

Results of the gamma scans are provided in the FSS Report in the form of maps showing the gamma measurements results in color bands of concentration equivalent, depending on the radionuclide. In the maps provided in the original surface FSS Report (ref. 7), the lowest two bands are both a dark green color; and the two colors are not distinguishable on the maps. This was a concern to Staff especially for Th-232. For Th-232, the DCGL<sub>w</sub> is 3.7 pCi/g. In the maps for Th-232, the second color band (i.e., 3.7–7.4 pCi/g) represents concentrations from the DCGL<sub>w</sub> to twice the DCGL<sub>w</sub>. Given that investigation levels have not been described and that NRC Staff cannot distinguish levels that are less than the DCGL<sub>w</sub> from levels that might be up to twice the DCGL<sub>w</sub>, it was unclear to the Staff if the gamma survey supports NFS's conclusion that concentrations were uniform and there were no areas warranting investigation.

The Staff asked NFS for additional information about these aspects of the gamma scans in an RAI in December 2011 (ref. 8). In its March 2012 response (ref. 9), NFS stated that the primary intent of the gamma scanning was to provide a qualitative evaluation of how the entire surface of Survey Units 1 and 2 compared to the soil sampling locations. NFS also stated that an MDC for the survey unit as a whole could be calculated from the individual logged data. The Staff agrees that the primary objective of the gamma scanning is a qualitative assessment, with one intent being to evaluate how the entire area compares to the soil sampling locations. Another related intent of the scanning is to evaluate whether significant elevated areas exist, that might not be found by the soil sampling alone. For either purpose, the Staff concludes that the gamma scanning system used by NFS, which used two 3-inch by 3-inch NaI detectors with a global positioning system and data logging to continually capture count rate data, has sufficient sensitivity for the surface gamma scans.

In its March 2012 response (ref. 9), NFS also committed to adjusting the color scale of the Th-232 maps, to provide a better visual evaluation of the lower concentrations. In the revised FSS Report, submitted in November 2012 (ref. 11), NFS included a second version of the Th-232 gamma scan map (on page 5 of Appendix 1 for Survey Unit 1 and page 6 of Appendix 1 for Survey Unit 2). In a supplemental submittal, NFS provided further revisions of the Th-232 gamma scan maps (ref. 15). NFS states that the first map uses a discrete color scale and shows that the Th-232 concentrations across the survey unit are below the DCGL<sub>w</sub> (ref. 11). The revised maps (ref. 15) provide a clear color distinction above and below the DCGL<sub>w</sub>. The Staff agrees that the maps show that essentially all of the area of the survey units appears to have concentrations no greater than the DCGL<sub>w</sub>. The Staff concludes that the map for Survey Unit 1 does show extremely localized areas (much less than 1% of the survey unit area) where the concentration could exceed the DCGL<sub>w</sub>, but these are too small to have any significant impact on the average concentration for the survey unit. NFS further states (ref. 11) that the second map, using a continuous color scale, shows that concentrations are largely uniform across the survey unit with no spatially correlated elevated measurements. The revised second map (ref. 15) shows most of both survey units have estimated concentrations significantly less than the DCGL<sub>w</sub>, and the limited areas with somewhat higher concentrations (still less than the DCGL<sub>w</sub>) do not indicate any spatial correlation. Thus, the Staff agrees with NFS's conclusions from the results of the gamma scans. In particular, the Staff concludes that the scan maps indicate that (1) essentially all data indicate concentrations no greater than the DCGL<sub>w</sub>, (2) most of the data points indicate concentrations significantly less than the DCGL<sub>w</sub>, and thus (3) the scan data indicate the average concentration is less than the DCGL<sub>w</sub>.

#### 4.4.2. Findings

The Staff finds that the gamma scans were performed using appropriate and acceptable methods. The Staff finds that results of the gamma scans indicate that the average concentrations of the gamma-emitting radionuclides are less than the DCGL<sub>w</sub>, there is no indication of a spatial pattern of elevated concentrations, and thus the surface residual radioactivity in Survey Units 1 and 2 is within the criteria.

#### 4.5. Minimum Detectable Concentration Results for Soil Samples

##### 4.5.1. Evaluation

One quality control requirement for the in situ gamma spectroscopy and soil sample analyses is MDCs that must be met for the analyses. Table 5.3 of the DP provides the MDCs that NFS planned to meet for use of the in situ gamma spectroscopy measurements. Section 5.4.5 of the DP indicates that soil sample measurements (i.e., laboratory measurements) would also meet the same specifications. The actual MDCs for the sample measurements as performed are provided in Appendix 2 to the FSS Reports. In the original surface FSS Reports (ref. 7), the MDCs reported for the U-238 analyses were much greater than the criterion of <3 pCi/g (from Table 5.3 of the DP). In addition, two results for Th-232 in Survey Unit 2 had MDCs that were much greater than the criterion of <0.5 pCi/g (from Table 5.3 of the DP). A number of other Th-232 results had MDCs somewhat greater than the criterion. The Staff concern was that if the MDCs for the analyses are excessive, then the results may be of insufficient quality for an FSS. The Staff asked NFS for additional information about the MDCs for the soil sample analyses in an RAI in December 2011 (ref. 8).

In its March 2012 response (ref. 9), NFS committed to reanalyze the soil samples with a longer count time in order to produce uncertainties and MDCs that satisfy the requirements of the DP. In the revised FSS Report, submitted in November 2012 (ref. 11), NFS provided results of the reanalysis of the soil samples. The samples were counted for a longer time. However, it appeared to the Staff that all MDCs for the U-238 analyses and some of the MDCs for the Th-232 analyses were still greater than the criteria for the MDCs. In a supplemental submittal (ref. 15), NFS provided additional information, including results of a further reanalysis of the samples. The reanalyses involved alpha spectroscopy performed at an offsite laboratory and the results met the MDC criteria for U-238 and Th-232 analyses from the DP.

In addition, the tables providing the results in Appendix 2 of the November 2012 revised reports (ref. 11) were illegible. In its August 2013 supplemental submittal (ref. 15), NFS provided clearer versions of the data and quality control information, which are legible and provide an acceptable record of the data.

##### 4.5.2. Findings

The Staff finds the MDCs meet the criteria provided in the DP and are thus acceptable.

#### 4.6. FSS In Situ and Soil Sample Results and Demonstration of Compliance with DCGL<sub>WS</sub>

##### 4.6.1. Evaluation

For the surface surveys of Survey Units 1 and 2, NFS obtained soil samples and made in situ gamma spectroscopy measurements at the same location. Results are provided in the surface FSS Reports (ref. 11). For evaluation of the fixed measurement (i.e., in situ) and soil sample results for compliance with the surface DCGL<sub>WS</sub>, NFS calculated sum of fraction (SOF) values (sum of the ratios of measured concentrations to DCGL<sub>W</sub> values for all radionuclides). If all individual samples from a survey unit have an SOF (relative to the surface DCGL<sub>W</sub>) no greater than 1, then the survey unit passes without further statistical analyses. Per the DP, the surface DCGL<sub>WS</sub> are the following concentrations: U-235, 74 pCi/g; U-238, 306 pCi/g, Am-241, 130 pCi/g; and Th-232, 3.7 pCi/g.

For Survey Units 1 and 2, results of analyses for gamma-emitting radionuclides (see Section 4.3 for discussion of hard-to-detect radionuclides) are reported by NFS as follows:

- In situ gamma spectroscopy was performed at each soil sampling location. Results were converted to concentrations of U-238, Th-232, and K-40 (K-40 is naturally occurring). Results in regions of interest for Am-241 and U-235 were only provided in count rates (not converted to concentration); NFS stated these count rates were to confirm concentrations did not change across the survey unit.
- In situ count rates for Am-241 and U-235 appeared relatively consistent for the different locations in Survey Units 1 and 2.
- In situ estimated concentrations were:
  - In Survey Unit 1, U-238 up to 0.73 pCi/g, Th-232 up to 0.97 pCi/g, and the SOF for the two radionuclides was up to 0.26.
  - In Survey Unit 2, U-238 up to 1.96 pCi/g, Th-232 up to 0.59 pCi/g, and the SOF for the two radionuclides was up to 0.16.
- Concentration results from the soil samples were:
  - In Survey Unit 1, U-235 up to 0.28 pCi/g, U-238 up to 1.61 pCi/g, Th-232 up to 2.4 pCi/g, Am-241 up to 0.89 pCi/g, and the SOF for the four radionuclides was up to 0.65.
  - In Survey Unit , U-235 up to 0.30 pCi/g, U-238 up to 2.08 pCi/g, Th-232 up to 2.7 pCi/g, Am-241 up to 0.14 pCi/g, and the SOF for the four radionuclides was up to 0.73.

NFS stated that for Survey Units 1 and 2, based on the soil sample results, all of the sample SOF values is less than 1.0. NFS concluded that the surface of Survey Units 1 and 2 meet the established requirements for release. The Staff reviewed the analyses of individual sample concentrations and SOFs. The soil sample results are provided in Table 3 in each of the two surface FSS reports, revision 2, enclosed in the NFS supplemental information (ref. 15). In these tables, the concentrations of U-235, Th-232, and Am-241 are indicated to be “moisture corrected results,” but the concentrations of U-238 are indicated as “not corrected for moisture.” In Appendix 3 of the reports, the laboratory data sheets state that the U-238 analyses are reported on a dry weight basis. The Staff sees the inconsistency in terminology in Table 3 as an indication that the results for U-235, Th-232, and Am-241 may be on a wet weight basis, which would be inappropriate. The Staff did not find a clear statement in the FSS Reports to clarify which basis (dry or wet basis) was used for U-235, Th-232, and Am-241. The Staff independently evaluated the impact if the result were on a wet weight basis, based on the moisture content values provided in the Table 3. If the results were on a wet basis, the conversion to dry weight basis results in a maximum SOF of 0.80 for Survey Unit 1 and 0.98 for Survey Unit 2. Thus, since none of the individual sample SOFs exceeds 1, the Staff agrees with the conclusion that the SOF values are no greater than 1 for Survey Units 1 and 2. The basis (wet or dry) of the samples does not impact that Staff conclusion.

#### 4.6.2. Findings

The Staff finds that the results of the surface soil sampling survey demonstrate that the surface residual radioactivity in Survey Units 1 and 2 are within the criteria.

#### 4.7. Potential for Re-contamination and Disturbance

##### 4.7.1. Evaluation

NFS is not requesting a partial site release of Survey Units 1 and 2 at this time; instead, NFS is requesting “confirmation that these survey units will be suitable for unrestricted release in accordance with 10 CFR, Part 20, Subpart E” (ref. 1 and ref. 5). Decommissioning activities continue in other parts of the North Site area, giving rise to a potential for re-contamination of Survey Units 1 and 2. In the DP, NFS discusses prevention of re-contamination of decommissioned areas. When partial site release is requested, the potential for re-contamination or other disturbance of the survey unit areas must be considered.

#### 5. Conclusion

For the surface soils, the Staff finds that the FSSs for Survey Units 1 and 2 were performed in a manner consistent with the surface FSS Plan in the DP, and the results are within the criteria.

#### 6. Recommendations

The Staff approves confirming that the *surface* soils of Survey Units 1 and 2 will be suitable for unrestricted release, subject to the caveat described in Section 4.7.

#### 7. References

1. Letter from NFS dated July 8, 2009 (package ML091980385)
2. Letter from NRC dated December 3, 2009 (ML093360179)
3. Letter from NFS dated December 31, 2009 (ML100120281)
4. Conference call summary dated January 27, 2010 (ML100280989)
5. Letter from NFS dated May 24, 2010 (package ML101580442)
6. Letter from NRC dated June 15, 2010 (ML101600349)
7. Letter dated August 16, 2011 (package ML112351126)
8. Letter from NRC dated December 21, 2011 (package ML113260527)
9. Letter from NFS dated March 1, 2012 (ML12066A075)
10. Meeting summary e-mail dated September 25, 2012 (ML12270A027)
11. Letter from NFS dated November 14, 2012 (package ML123280071)
12. Letter from NFS dated March 25, 2013 (package ML130990501)
13. Letter from NRC, with enclosed safety evaluation report, dated June 10, 2013 (package ML13130A116)
14. Letter from NFS dated October 8, 2012 (package ML122970097)
15. Letter from NFS dated August 12, 2013 (package ML13234A173)
16. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, NUREG-1575, Rev. 1, August 2000.

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